Medical Informatics

Sorana D. BOLBOACĂ

OUTLINE

Definition
Introduction
Medical Experts Systems
Medical Documentation

Definition

- = the application of computer and information science to improve *medical practice*, *research*, *education* and *management*

Medical Informatics: Education

- General:
  - MedicalStudent.com - a digital library of authoritative medical information for all students of medicine
  - Virtual Naval Hospital - a digital library of naval medicine and military medicine and humanitarian medicine
- Anatomy:
  - Atlas of Human Anatomy: http://www.anatomyatlases.org/atlasofanatomy/index.shtml
  - Atlas of Human Anatomy in Cross Section: http://www.anatomyatlases.org/HumanAnatomy/CrossSectionAtlas.shtml

Medical Informatics: Education

- Histology atlases:
  - http://www.deltagen.com/target/histologyatlas/HistologyAtlas.html
  - http://histologyatlas.wisc.edu/uw/histo.htm
  - http://www.micron.uerj.br/atlas/atlasenglish/Menu.htm
  - http://www.histol.chuvashia.com/atlas-en/content-en.htm
  - …

Medical Informatics: Education

- **Decision support system for diagnosis in medicine:**
  - How does the case-based decision-support system could assist students in learning oral pathology process?
  - What types of inference mechanisms are used to diagnosing oral pathologies?

  - Borra RC, Andrade PM, Corrêa L, Novelli MD. Development of an open case-based decision-support system for diagnosis in oral pathology. Eur J Dent Educ. 2007 May;11(2):87-92.

Medical Informatics: Clinical Practice

- Computer expert system for the histopathologycal diagnosis of salivary gland neoplasms:
  - How does the diagnostic performance of the expert system compare to the diagnostic performance of human experts?
  - What types of inference mechanisms are particularly well-suited to diagnosing salivary gland neoplasms?

  - Firriolo FJ, Levy BA. Computer expert system for the histopathologic diagnosis of salivary gland neoplasms. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 1996 Aug;82(2):179-86.

Medical Informatics: Clinical Practice

- Clinical Decision Support Systems:
  - How a clinical decision support system could provide relevant and current evidence to providers to substantially improve health care quality?
  - How a clinical decision support system could provide relevant and current evidence to providers to potentially reduce errors in practice?
    - "Must-have" applications are defined as essential to the functioning of a dental practice.
    - "nice-to-have"
    - "optional"
  - Mendonça EA. Clinical Decision Support Systems: Perspectives in Dentistry. J Dent Educ 2004;68(6):589-597.s

Medical Informatics: Clinical Practice

- Usability of four practice management systems:
  - Which usability problems are common in medical software?
  - What is the rate of completed incorrectly completed and incomplete user tasks?

Electronic Education in Medicine

- Why?
  - Active leaner-centered learning NOT passive-centered learning
  - Less expensive continuing dentistry education
  - Enable just-in-time training:
    - the physicians having the opportunity to follow the training when they consider that is necessary for their practice, and being able to tailoring the learning experience, time and place continuing medical development to personal preferences.
  - …

Electronic Education in Medicine

- On-line electronic handouts
- On-line interactive modules
- On-line real time video cast
- Databases
- Applications
- Electronic textbooks and notes:

- …

Expert systems

- Expert system (ES) = a computer program that uses knowledge and inference procedures of an expert to solve problems.
- Early Expert Systems (1970s)
  - DENDRAL: infers molecular structure from the unknown compounds
  - MYCIN: medical diagnosing (bacterial infections on the blood)

- *The expert knowledge provides the key to expert performances, while the knowledge representation and inference schemes provide the mechanism for its use*

E. Feigenbaum

Expert Systems

- Human problem solvers are good only if they operate in a very narrow domain.
- Expert systems must be constantly updated with new information.
- The complexity of problems requires a considerable amount of knowledge about the problem area.

Expert System

- Expertise = extensive, task-specific knowledge acquired from training, reading, and experience
- Include:
  - Theories
  - Rules and procedures
  - Heuristics
  - Global strategies
  - Meta-knowledge
- Heuristics = rules of experience that characterize expert-level decision making in the field
- Transferring expertise:
  - Expert → computer → non-expert
  - Knowledge acquisition (from experts and other sources)
  - Knowledge representation (in the computer)
  - Knowledge inference
  - Knowledge transfer to the user

Expert Systems

- Shallow knowledge (experience): consists of all the peculiar heuristics and shortcuts
  - IF it rains
  - THEN the vegetables will grow faster
- Deep knowledge (theoretical): first principles, axioms, laws:
  - IF it rains
  - THEN the vegetables will grow faster
  - BECAUSE the soil will become more moist
- Expert systems are tailored-made for specific and narrowly-defined problem domains.

Expert Systems Tasks

- Interpretation: inferring situation descriptions from sensor data
- Prediction: inferring likely consequences of given situations
- Diagnosis: inferring malfunctions from observations
- Prescription: prescribing remedies under constraints
- Design: configuring objects under constraints
- Planning: designing actions
- Monitoring: comparing observations to expected outcomes
- Control: governing overall system behavior
- Instruction: diagnosing, prescribing and guiding users' behavior

Expert Systems: Functions

- To draw conclusions
- To explain its reasoning
  - HOW was a conclusion reached?
  - WHY the program asks the user a particular question?
  - TRACE displays all rules that are tired.
  - WHAT-IF explains what will happen if a certain value of rule is changed.

Expert Systems: Components

- Working memory: holds the symbol structure which represents the states of the problem space.
- Production memory (long-term memory): holds the production rules.
- Control strategy: selects the rules to be applied (order rules, specificity)

Expert Systems: Advantages

- Availability:
  - it never gets tired or dies
  - Knowledge is often more readily available to users
- Consistency:
  - Even the best expert can make mistakes or may forget an important point; an expert system did not!
- Comprehensiveness:
  - Could integrate more knowledge than an expert.

Expert Systems: Disadvantages

- Cannot easily adapt to new/unusual situations; not creative
- Do not learn by experience
- Not good at representing spatial knowledge
- No common sense
- Expensive and time-consuming to develop

Expert Systems: Examples

- MYCIN
  - Shortliffe, 1976 (Stanford University)
  - Never put in practice
  - Diagnosis and treatment of meningitis and bacteremia infections
- PUFF
  - 1979
  - To interpret measurements related to respiratory tests and to identify pulmonary disorders

Expert Systems: Examples

- INTERNIST
  - 1970s (University of Pittsburg)
  - Diagnosis of the majority of diseases associated with the field of internal medicine
- ILIAD
  - University of Utah School of Medicine's
  - Internal medicine, diagnosis
  - http://www.openclinical.org/aisp_iliad.html
- HELP:
  - Knowledge-based hospital information system
  - http://www.openclinical.org/aisp_help.html

Expert Systems: Examples

- DoseChecker:
  - Barnes Hospital in Missouri
  - To assist pharmacists with monitoring drug orders for a set of drugs
- QMR:
  - University of Pittsburg
  - Assists physicians in the diagnosis of an illness based upon the patient's symptoms, examination findings and laboratory tests
- PEIRS:
  - Pathology Expert Interpretative Reporting System

Expert Systems: Examples

- AI (Artificial Inteligence) Systems in Clinical Practice
  - http://www.openclinical.org/aisinpracticeDSS.html

Expert Systems: Summary

- Imitate reasoning process of experts.
- The power of an ES is derived from its specific knowledge.
- Expertise is a task-specific knowledge acquired from training, reading and experience.
- Experts system technology attempts to transfer knowledge from experts and documented sources to the computer and make it available to non-experts.
- Expert systems provide limited explanation capabilities.

E-Medicine

- Continually updated clinical knowledge (emedicine from WebMD)
- Telemedicine (application of clinical medicine where medical information is transferred through the phone or the Internet and sometimes other networks for the purpose of consulting, and sometimes remote medical procedures or examinations)
- …

E-Medicine: Electronic Patient/Health Records

- ADA Commitment:
  - The American Dental Association believes that, for optimal patient benefit, with assurance of confidentiality safeguards, appropriate health information should be available at the time and place of care to practitioners authorized by the patient through the development of a computer-based patient health record.

E-Medicine: Electronic Patient/Health Records

- Electronic Health Record Criteria:
  - Quality -complete and accurate information available
  - Utility -information presented in a form optimally suited to the user
  - Proximity -information available at the time and place needed
  - Accessibility -seamless availability across boundaries of healthcare profession, specialty, discipline or care delivery environment
  - Confidentiality -access to identity-linked information limited to those parties authorized by patient consent.

E-Medicine: Electronic Patient/Health Records

- Design Approach:
  - Top-down design
  - Fact-oriented
  - Flexibility and stability
  - Life-long continuous documentation
  - Focus on health condition

E-Medicine: Electronic Patient/Health Records

- Clinical Data Architecture:
  - Introduction, Architecture and Framework
  - Individual Identification
  - Codes and Nomenclature
  - Individual Characteristics
  - Population /Population Characteristics
  - Organization
  - Location
  - Communication
- Clinical Data Architecture:
  - Health Care Event
  - Health Care Materiel
  - Health Services & Outcomes
  - Health Service Resources
  - Population Health Facts
  - Patient Health Facts
  - Health Condition Diagnosis
  - Patient Service Plan
  - Patient Health Service
  - Clinical Investigation

E-Medicine: Electronic Patient/Health Records

- Interoperability:
  - Common terminology and codes sets
  - Consistent record content
  - Maps and crosswalks
  - Standards harmonization
- Surveillance Opportunities
  - Dentists as primary care providers
  - Semi-annual routine visits
  - Limited health history
  - Symptom observations

E-Medicine: Electronic Patient Records

- Examples:
  - CHITS Community Health Information Tracking System - EHR for public health community centres in developing countries
  - ClearHealth Clearhealth - Flexible and standards compliant EMR/EHR
  - elementalClinic - open source web-based EMR for mental health written in Perl, licensed under the GPL. Also available as a hosted service.
  - FreeMedForms - open source (c++/Qt4.5) highly dynamic EMR. FreeMedForms is released under the BSD license and is intended to be fully internationalized.
  - ...

E-Medicine: Evidence Based Medicine

- Evidence Based Medicine (journal):
  - For Primary Care and Internal Medicine
  - http://ebm.bmj.com/
- Center for Evidence Based Medicine:
  - http://www.cebm.net/ (Oxford, UK)
  - http://library.umassmed.edu/EBM/index.cfm
  - http://www.gpnotebook.co.uk/simplepage.cfm?ID=-1596981199
  - http://www.cebm.utoronto.ca/
  - …

E-Medicine

- Systematized Nomenclature of Medicine (SNOMENT)
  - Systematized Nomenclature of Medicine (SNOMED, a core terminology for the electronic health record)
  - Adoption of evidence-based practice
  - Electronic Health Record
  - Interoperability
  - Surveillance Opportunities

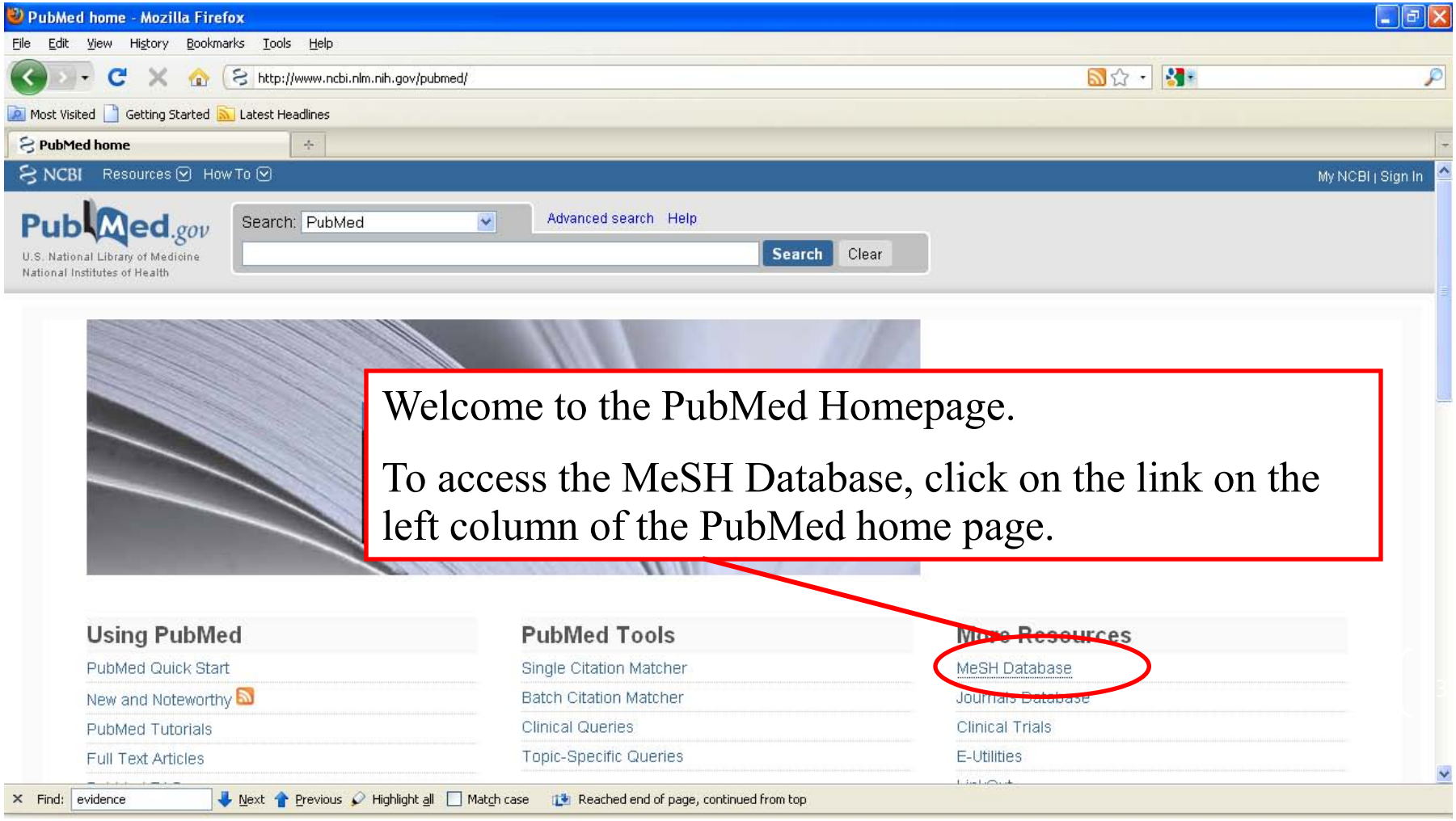
E-Medicine: SNOMENT

- Provides standardized terms for describing medical disease
- Captures clinical detail and patient characteristics
- Permits analysis of patient care services and outcomes
  - Addresses physical findings, risk factors, functional status

Medical Documentation

- Where to search?
  - Online databases (PubMED, ProQUEST, EBSCO, Embase, CABI, …)
  - Start with:
    - Evidence-based medicine databases
    - PubMED
- How to search?
  - Basic searches
  - Revising searches to find more of the relevant literature (limitations)
  - Selecting and downloading article (online or in print)

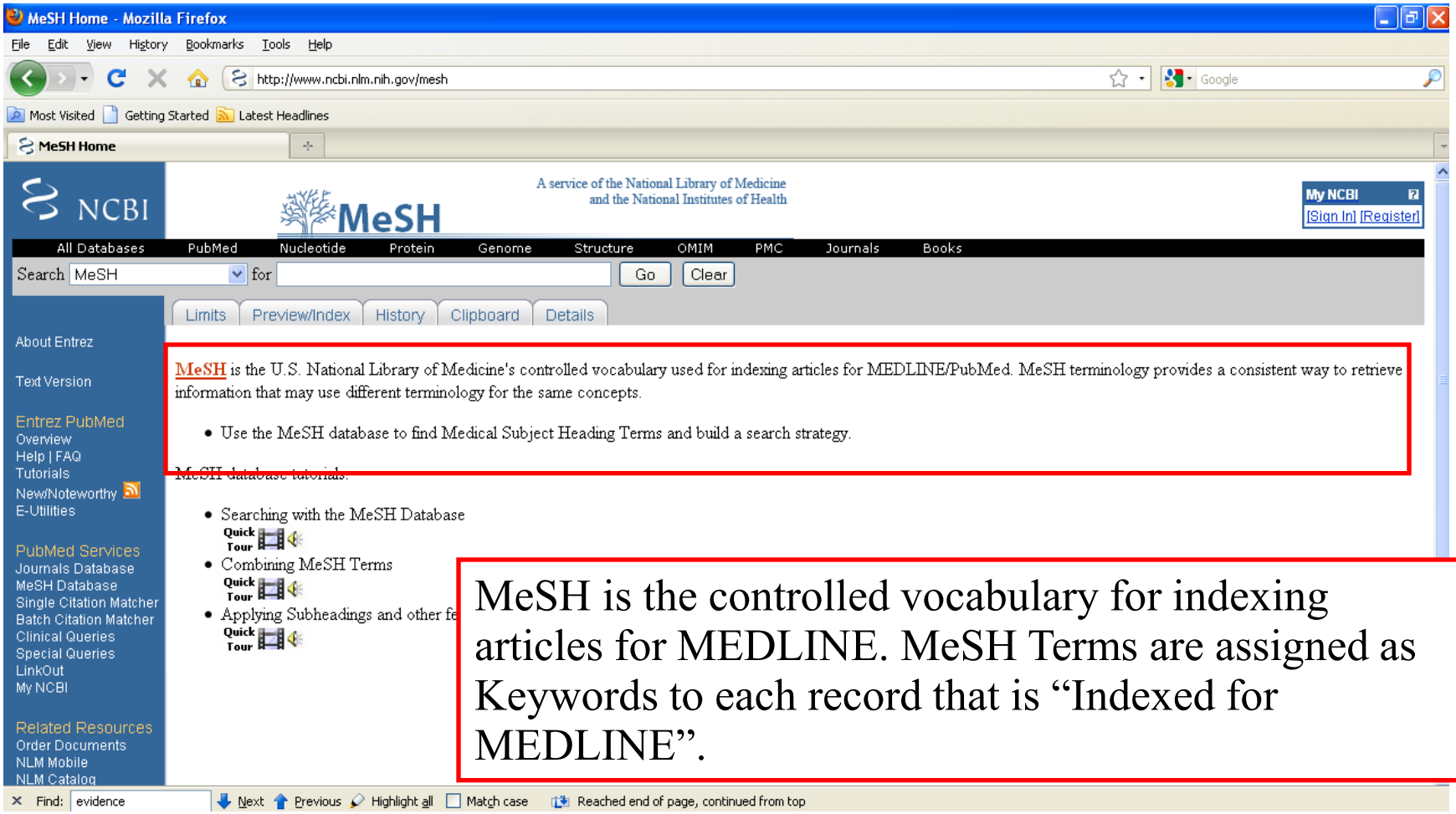
MEDICAL DOCUMENTATION: PubMED



Medical Documentation: PubMED

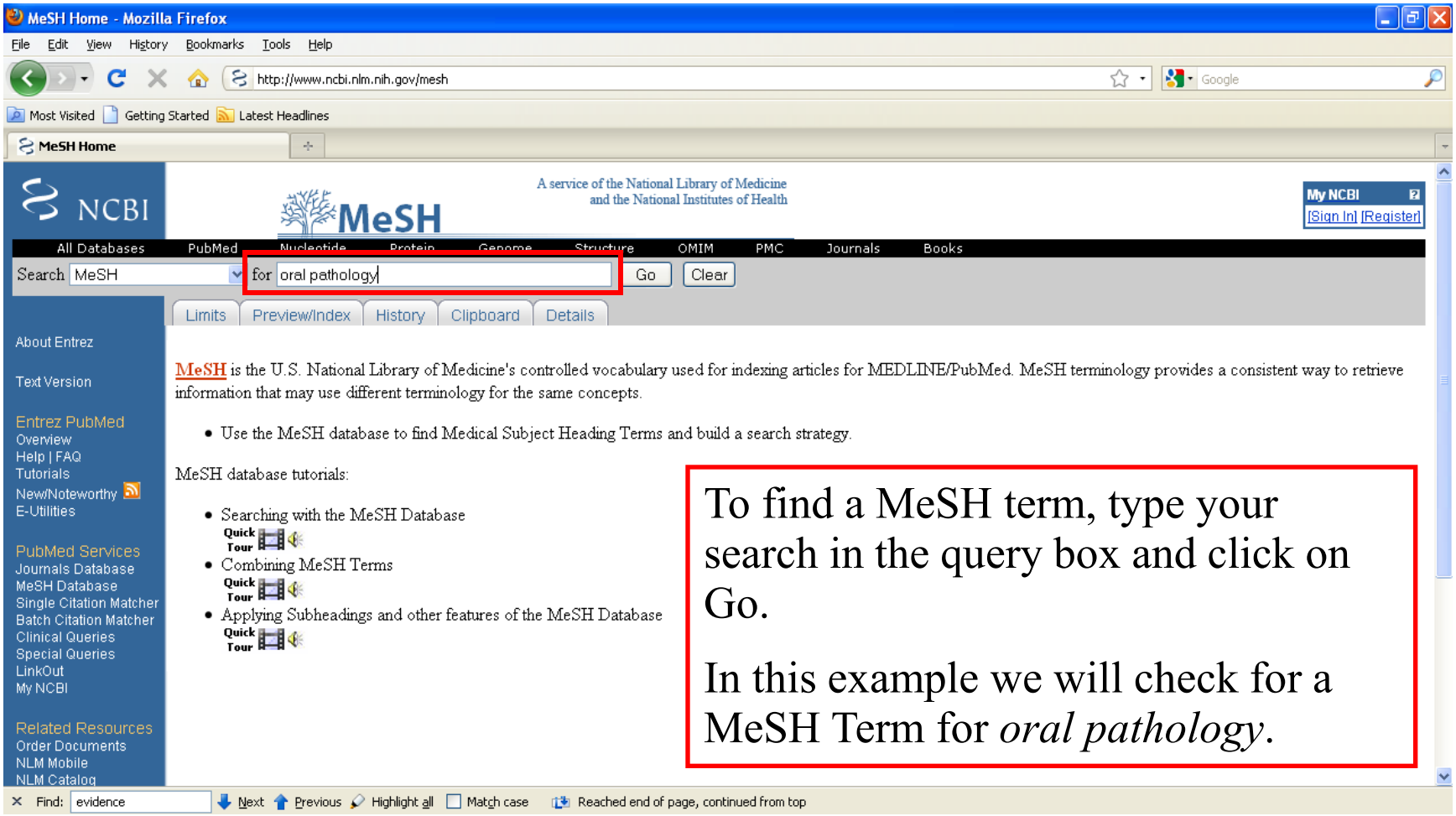
- Why should you use PubMed?
  - PubMed contains over 14 million citations of medical literature back to the 1953.
  - Over 4,600 medical journals are indexed yearly
  - Newspapers, life science journals, nursing journals, and medical management journals, and others are all covered in PubMed.
  - **This is not true of Medline found in other vendors!**
  - It is the best medical database of its kind in the world
  - It is free
  - Your patients use it
  - Your lawyers, drug reps, accountants and nursing staff use it.

MEDICAL DOCUMENTATION: MeSH



MeSH is the controlled vocabulary for indexing articles for MEDLINE. MeSH Terms are assigned as Keywords to each record that is “Indexed for MEDLINE”.

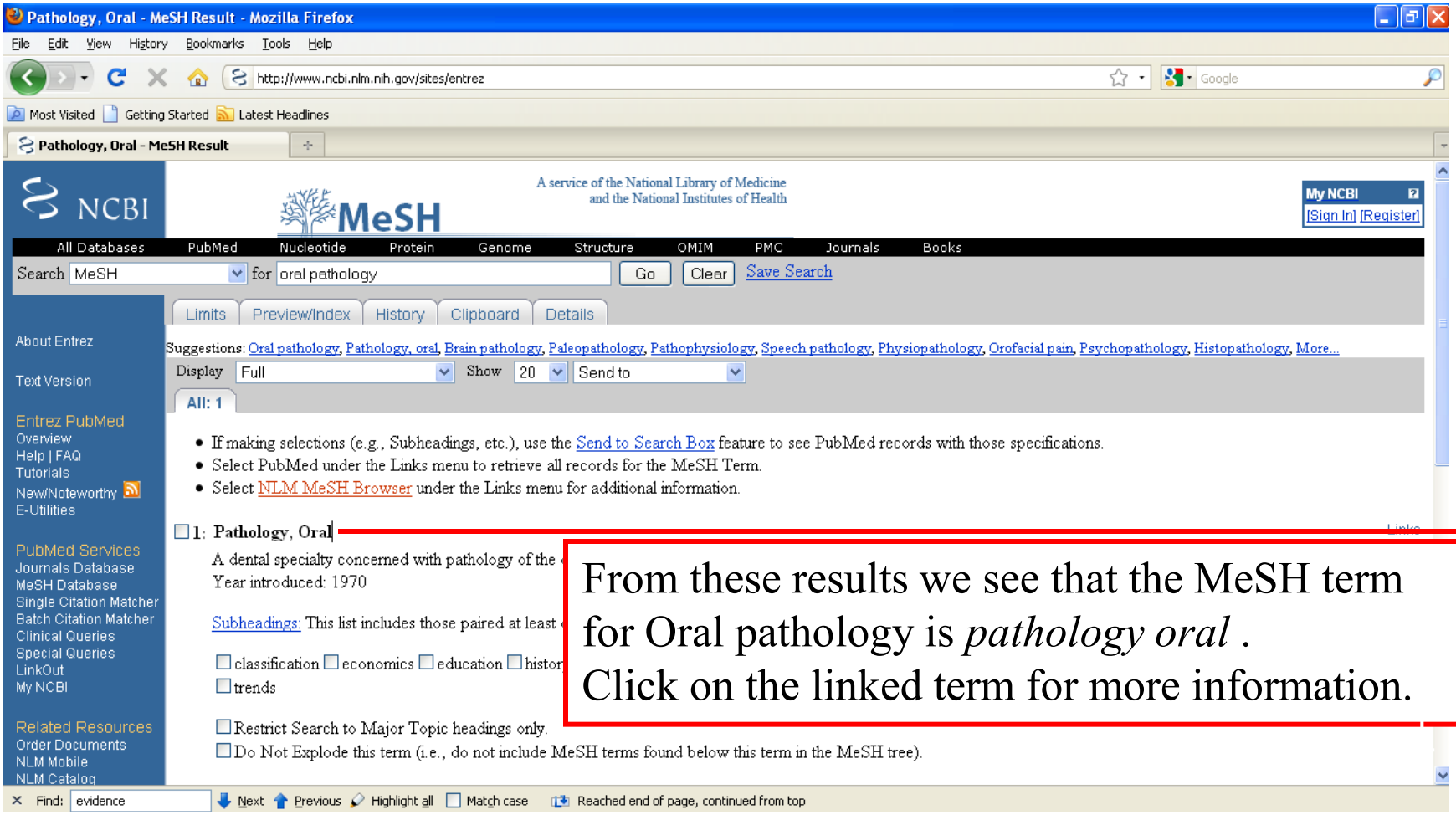
MEDICAL DOCUMENTATION: MeSH



To find a MeSH term, type your search in the query box and click on Go.

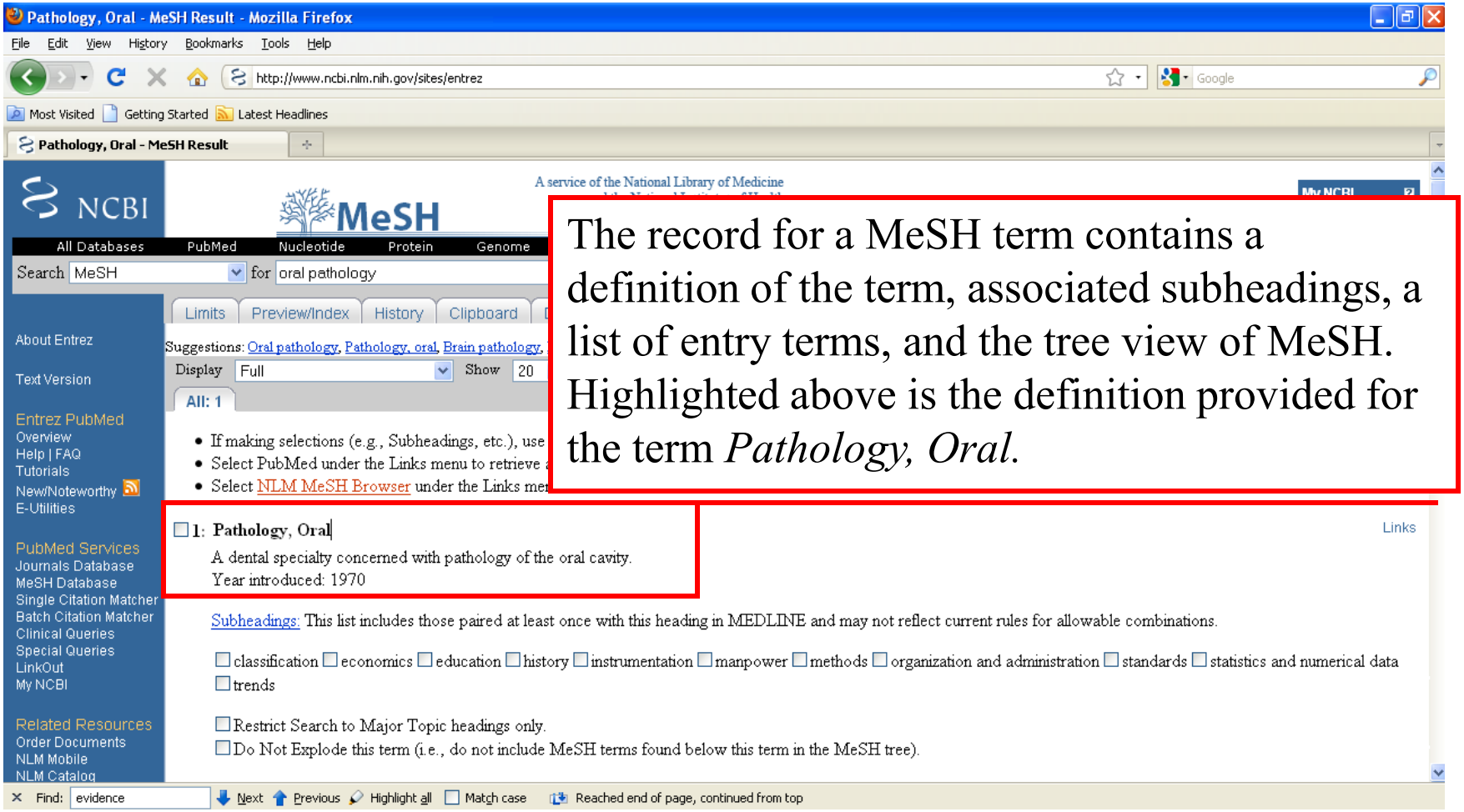
In this example we will check for a MeSH Term for *oral pathology*.

MEDICAL DOCUMENTATION: MeSH



From these results we see that the MeSH term for Oral pathology is *pathology oral* .
Click on the linked term for more information.

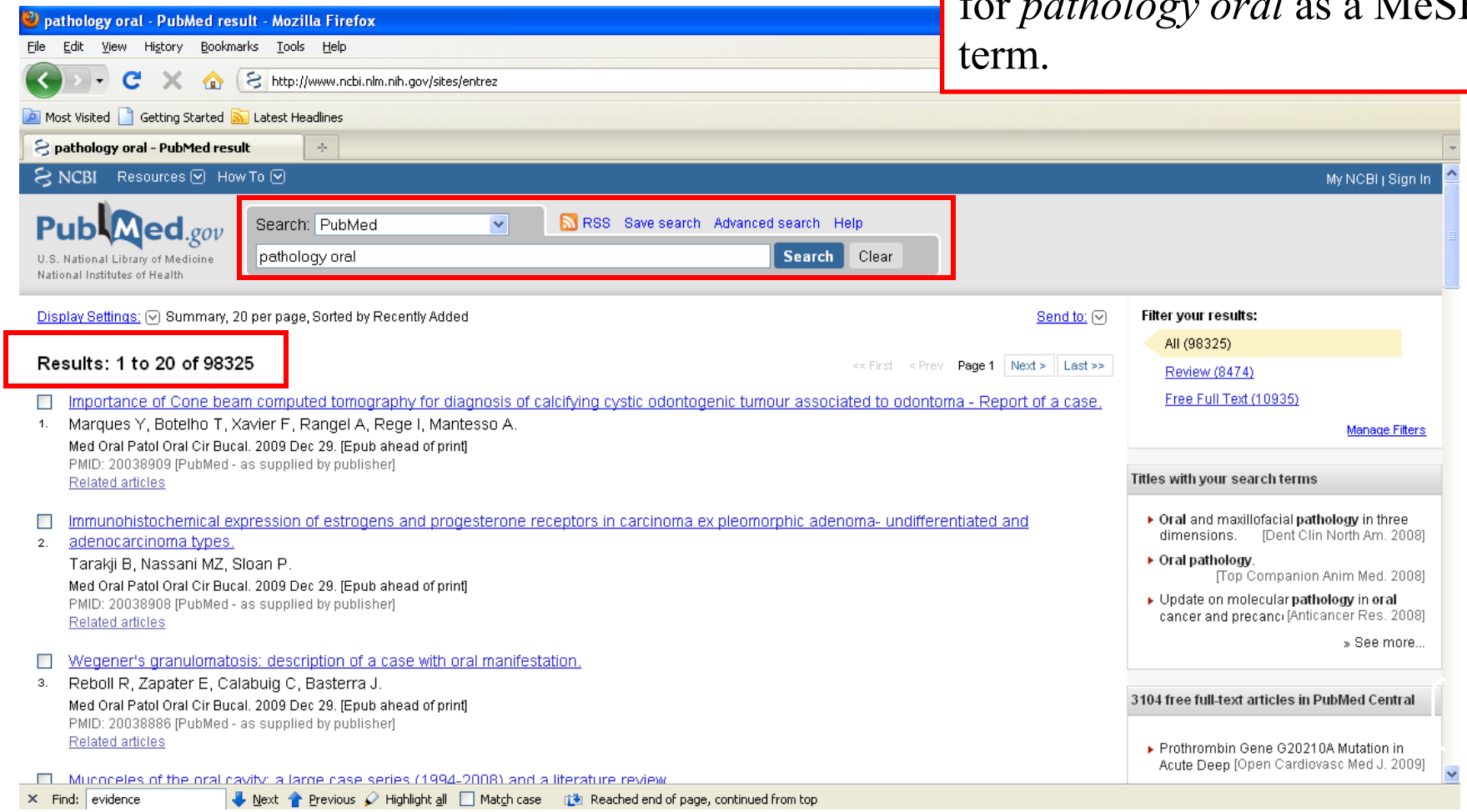
Medical Documentation: MeSH



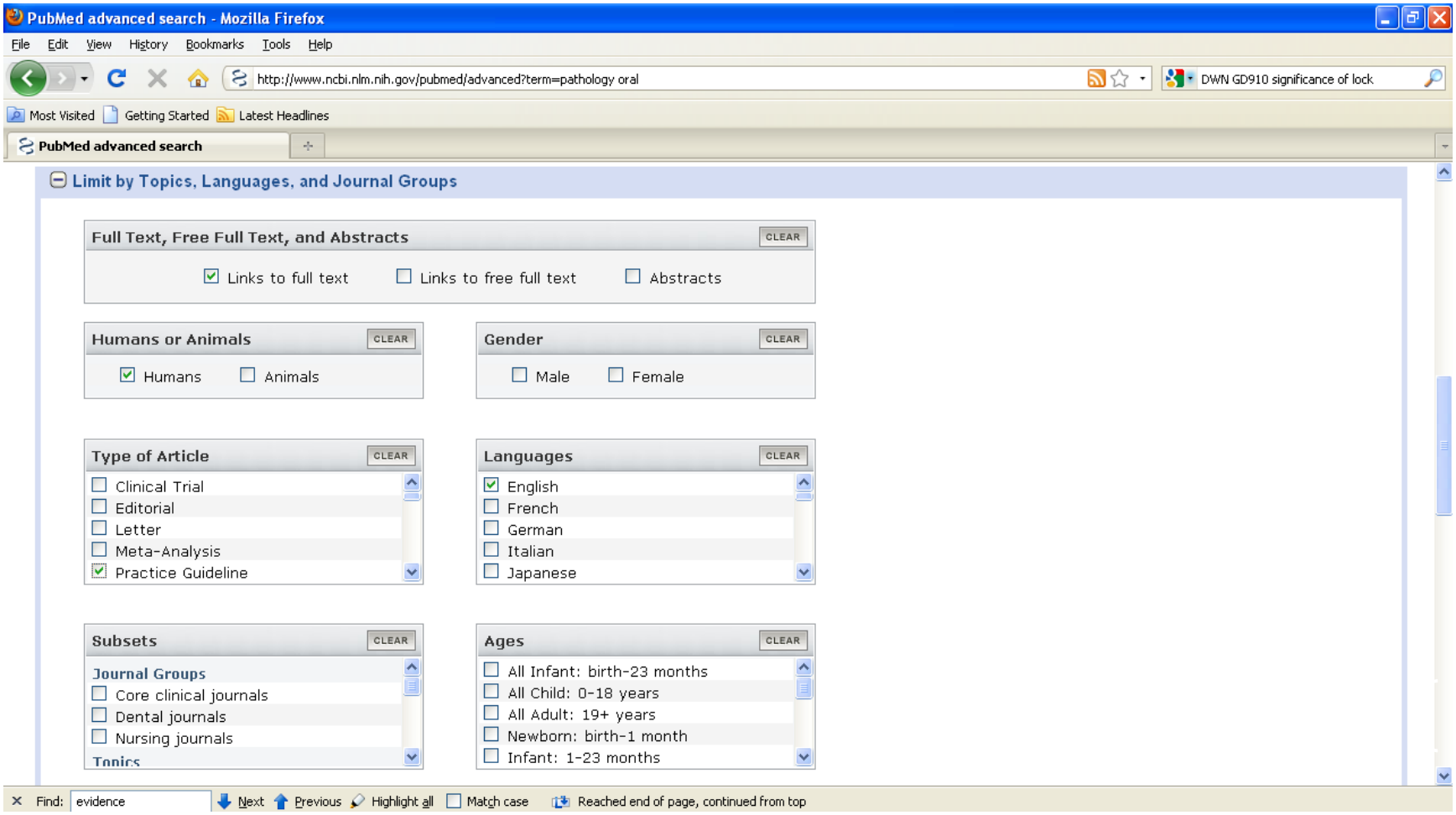
The record for a MeSH term contains a definition of the term, associated subheadings, a list of entry terms, and the tree view of MeSH. Highlighted above is the definition provided for the term *Pathology, Oral*.

MEDICAL DOCUMENTATION: PubMED

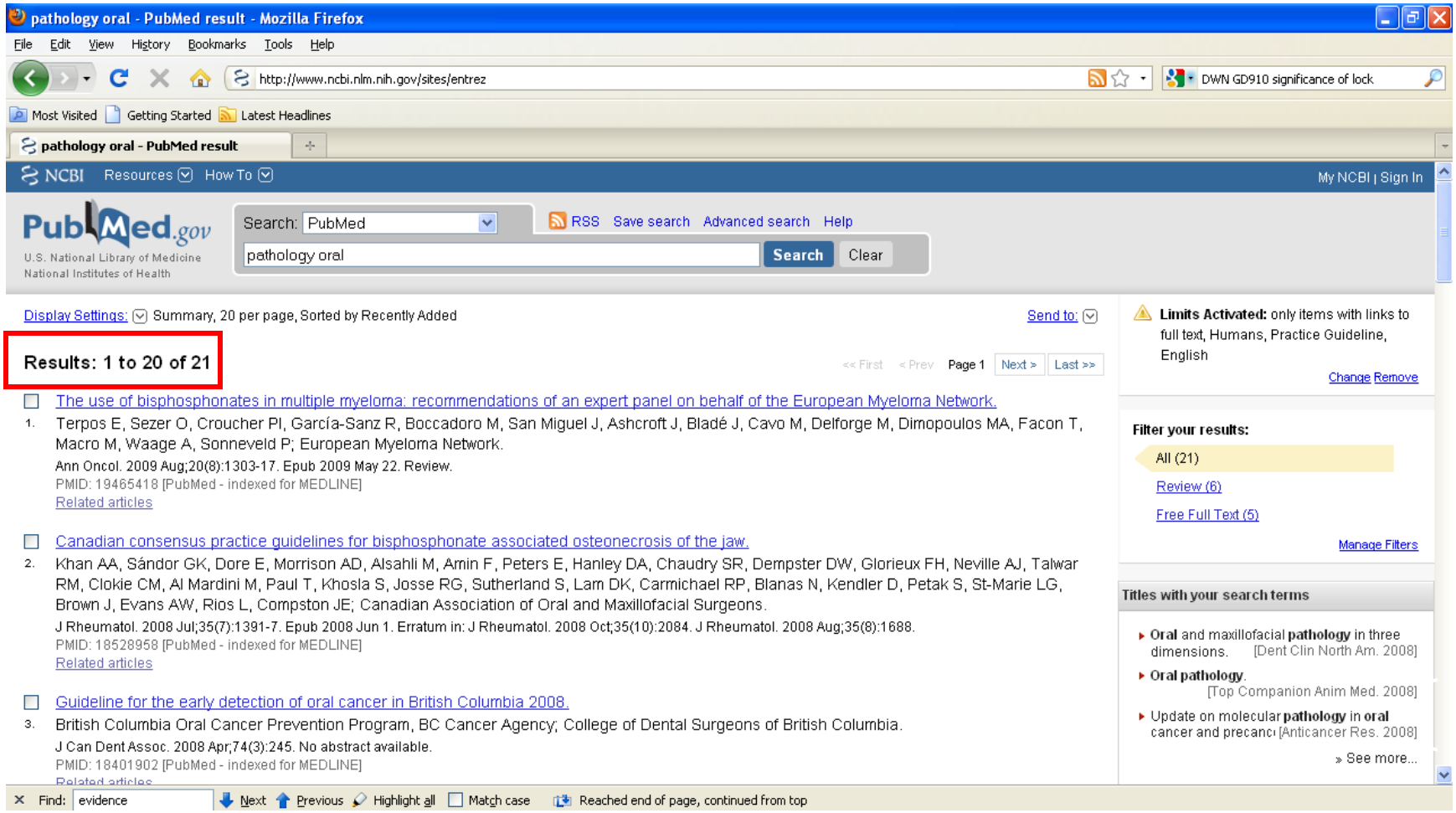
In this example, we will search for *pathology oral* as a MeSH term.



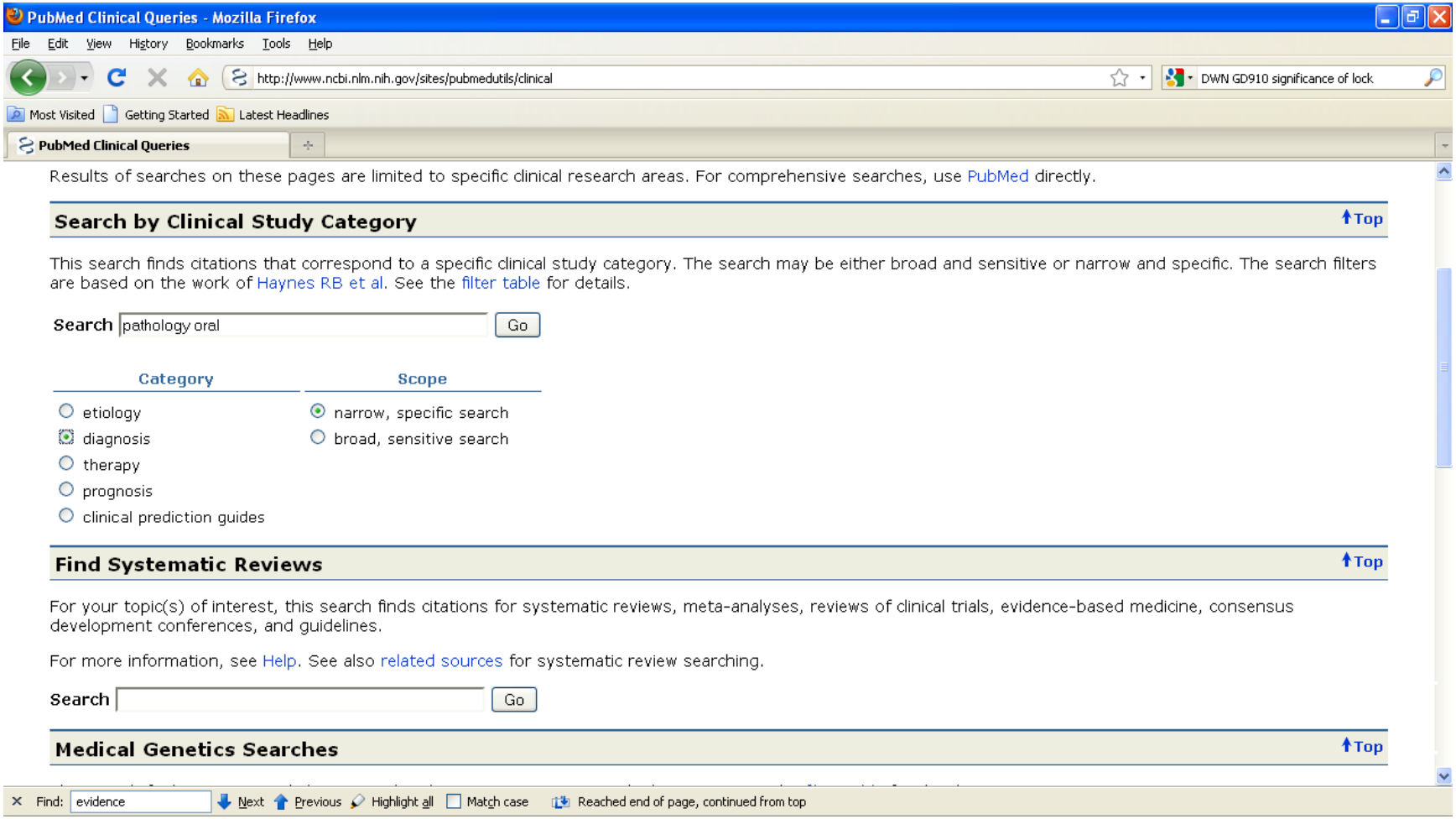
MEDICAL DOCUMENTATION: PubMED



MEDICAL DOCUMENTATION: PubMED



You have a very specific question? – You want a very specific answer?



Summary

Medical Informatics:

Data is not information, information is not knowledge, knowledge is not understanding, understanding is not wisdom.

Clifford Stoll

Medical Experts Systems:

Computers make it easier to do a lot of things, but most of the things they make it easier to do don't need to be done.

Andy Rooney

Medical Documentation

The Internet is not just one thing, it's a collection of things - of numerous communications networks that all speak the same digital language.

Jim Clark